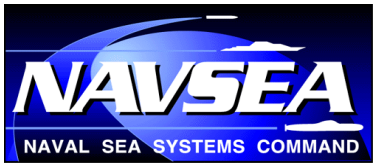
Configuration Status Accounting: Audit Sampling Procedures



Naval Sea Logistics Center-August 27, 2002

History

- Fleet requested that audits be reinstated
  - Goal: Baseline Ship's Configuration Accuracy
- NAVSEA 04L5 tasked NSLC to review audit procedures & perform Root Cause Analysis
  - Audit procedure re-working merged with the CDM/ISEA Validation WG (spring 2001)

Reference Material

- DoD 7600.7-M Internal Audit Manual
  - Establishes uniform policies and procedures
- MIL-STD-105E*
  - Outlines the sampling plans for “Acceptance” sampling
- National Institute of Standards and Technology
  - Provided web based interactive tool on MIL-STD-105E
  - Consulted Statistical Engineering Division at the National Institute of Standards and Technology
- Various books on Statistics and Internet Research
  - Web based statistical tools
  - University web sites

“Previous” Sampling Procedure

- Tech. Spec. 9090-700C Part A (Appendix 10- 5..9.1 e)
  - 2% Minimum Sample or 316 Type 2 records
    - MIL-STD 105E and DoD 7600.7-M Internal Audit Manual referenced as basis for sampling procedures

"Previous" Sampling Procedure: Problems

- Neither MIL-STD 105E or DoD 7600.7-M Internal Audit Manual recommends a flat 2% sample size
  - When population is very large, 2% is inefficient
  - Produces inconsistent confidence levels from audit to audit
- MIL-STD 105E is an "Acceptance" sample plan suited for manufacturing processes
  - It does not apply to current configuration audit requirements
  - Does not give an estimation of overall accuracy; it only passes and fails by lots.

Shifting the Paradig

Statistical Sampling Concepts

- **Based on DoD 7600.7 Internal Audit Manual** (chapter 11)
  - Use statistical sampling with voluminous numbers
  - Allows auditor to determine risks in making estimates
  - Able to make conclusions about a population (universe) from a sample of that population
  - To ensure statistically valid conclusions it is essential that . . . some type of random selection be used

Key Statistical Terms

Confidence Level tells us how "sure" we can be about the results. It represents how often the true configuration accuracy of the total records lies within the confidence interval. Our 95% confidence level means we can be 95% certain that our results are within 3% of the ships' actual configuration accuracy. 95% is a common confidence level used by researchers._

Confidence Interval (Error Rate) is the plus and minus interval about the sample statistic. We can be "sure" (see confidence level for how sure) that if a ship's configuration accuracy turns out to be 95% based on our sample, the actual accuracy of the entire ship would be between 92% (95-3) and 98% (95+3).

Maximum Expected Error Rate This may be the most subtle of the factors. This measurement is used in calculating our sample size. It is the auditor's estimate of the maximum expected rate of occurrence of the event (error) in the field. This is **not** the expected rate anticipated by the auditor. Increasing the maximum expected error rate drives the samples size up. In other words, our maximum number of errors would be very nearly 50-50, then we would have to sample a larger sample to reach our confidence goals.

“Current Revised” Sampling Procedures

- Statistical Parameters
  - 95% Confidence Level*
  - 3% Error Rate*
  - 25% Maximum Expected Error Rate*
- Computer Generated Random Selection
- Across Entire Ship
- Limited Filters
  - More on this issue later in pitch

Advantages of a Statistical Methodology

- The sample result is objective and defensible
- Statistical sampling is cost-effective and time saving
- Statistical sampling can be more accurate than an examination of every item in a large population
- Objective evaluation of test results is possible

- Data may be combined and evaluated, even though obtained by different auditors
- Results give a consistent measurement—one confidence level for all ships

Choosing a Sampling Plan

At the ship level, **"How many"** of configuration records are accurate recorded in CDMD-OA?

- What is the goal of the audit?
- What data do you want?
- "Estimation" Sampling answers the question of **"how many"** or **"how much"**
- Two types of estimation sampling:
  - Attributes Sampling
    - "Is used when the question of "how many?" is pertinent. It is used to determine the characteristics or "attributes" of a population. The results are expressed as a percent of the type of event specified.
  - Variables Sampling
    - Used to answer "how much?" Applied to populations made up of dollars, pounds, days, etc.
- **The attributes plan is best suited for configuration audit purposes**

How to Select the Sample

Types of Sample Selections

- "Unrestricted" Random Numbers
  - Most common method of sampling
  - Each item in the population has an equal chance of being included in the sample
- "Stratified" Sampling
  - The items in the population are segregated into two or more classes or strata. Each strata is then sampled independently. The results for the several strata may be combined to give an overall figure for the universe.

See notes for more types of sampling selections. The two above are most applicable to configuration audits

Unrestricted vs. Stratified

- Unrestricted Random Numbers
  - Simple to execute
  - Cost effective
- Stratified Sampling
  - Use with heterogeneous population
  - Breaking data into groups (strata) can be problematic
    - For our purposes how do we stratify the data?
      - HSC, Location, APL, HM&E/Elec./Ordnance, System . . . ?
  - Increased cost and labor
  - Increased overall confidence level

Impact of Sample Selection: Unrestricted vs. Stratified

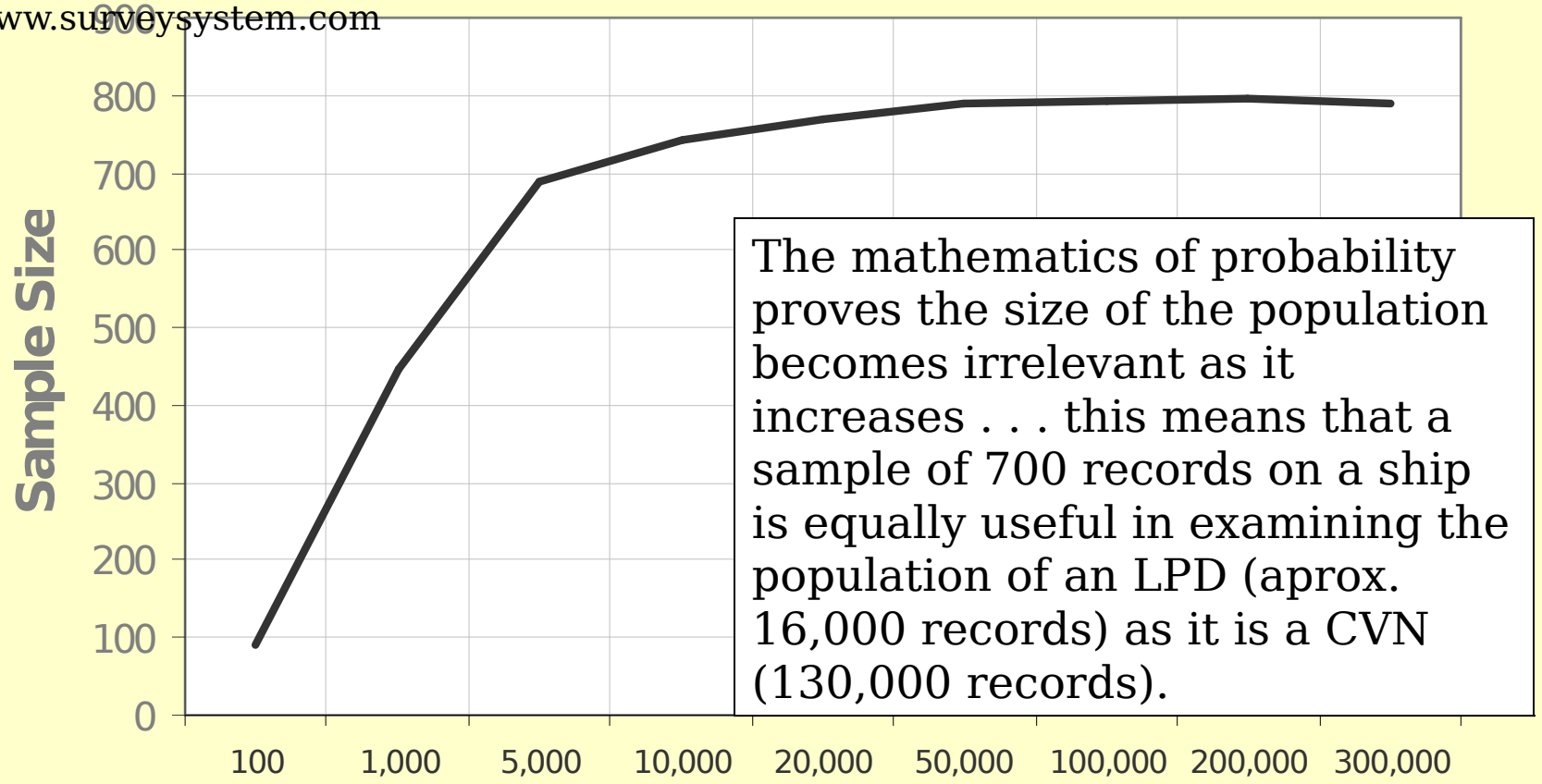
	CDMD-OA Population by Discipline Code	Unrestricted Random Numbers	Random Numbers Stratified by Discipline
CVN 65			
HM&E	96,256		794
Ordnance	627		352
Electronics	13,998		757
Total Ship	110,881	**795**	**1,903**
LPD 9			
HM&E	11,300		747
Ordnance	188		152
Electronics	2,715		618
Overall Ship	14,203	**758**	**1,517**
DDG 76			
HM&E	19,140		768
Ordnance	763		391
Electronics	6,800		716
Overall Ship	26,703	**777**	**1,875**
Total Records Across Three Ships		**2,330**	**5,295**
Estimated Cost Impact*			
Multiply by $20/candidate		**$46,600**	**$105,900**

Stratifying by discipli more then doubles sample size . . .

. . . and the cost

Impact of Population on Sample Size

Source: Creative Research Systems
www.surveysystem.com

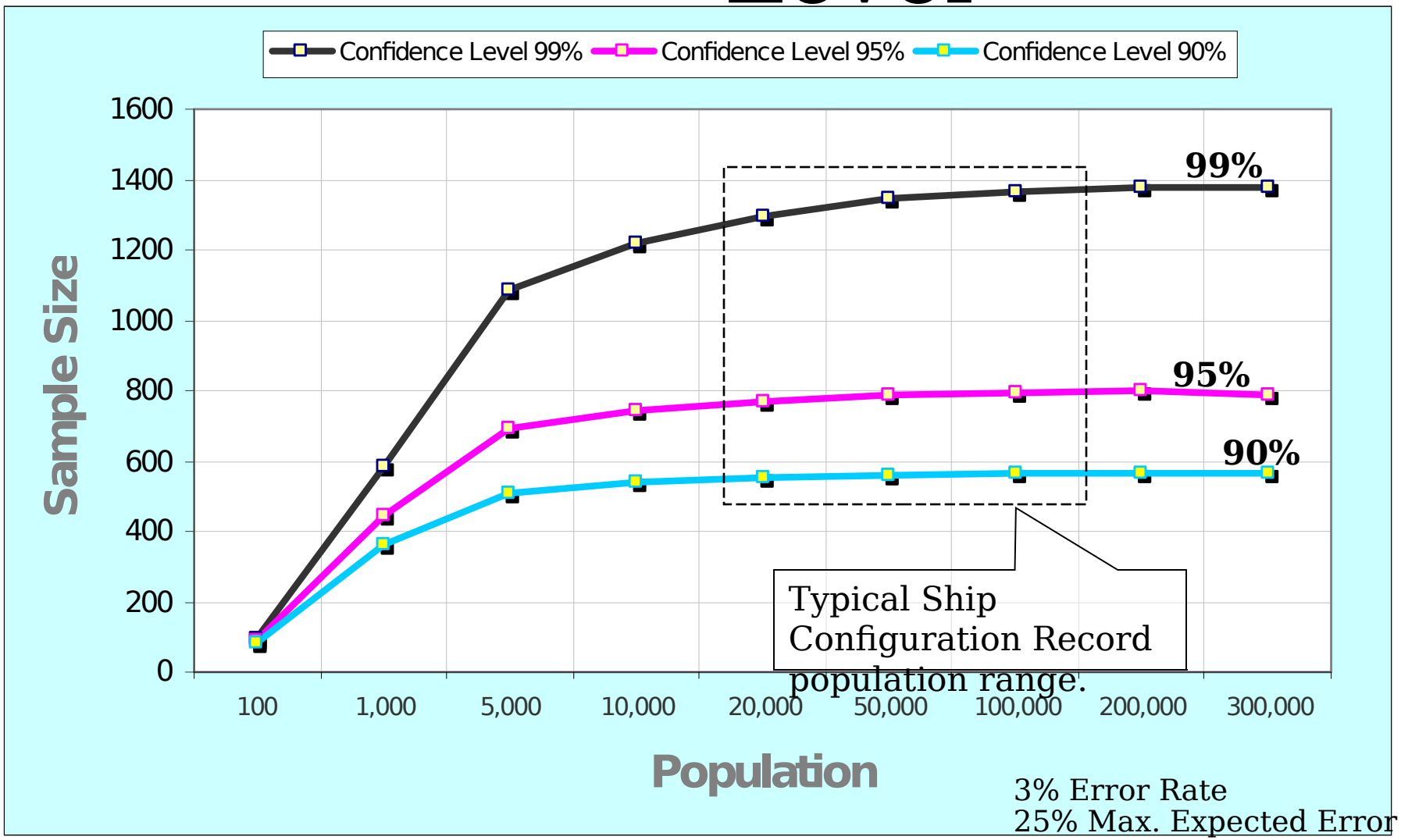


The mathematics of probability proves the size of the population becomes irrelevant as it increases . . . this means that a sample of 700 records on a ship is equally useful in examining the population of an LPD (aprox. 16,000 records) as it is a CVN (130,000 records).

"Population size is only likely to be a factor when you work with a relatively small and known population."

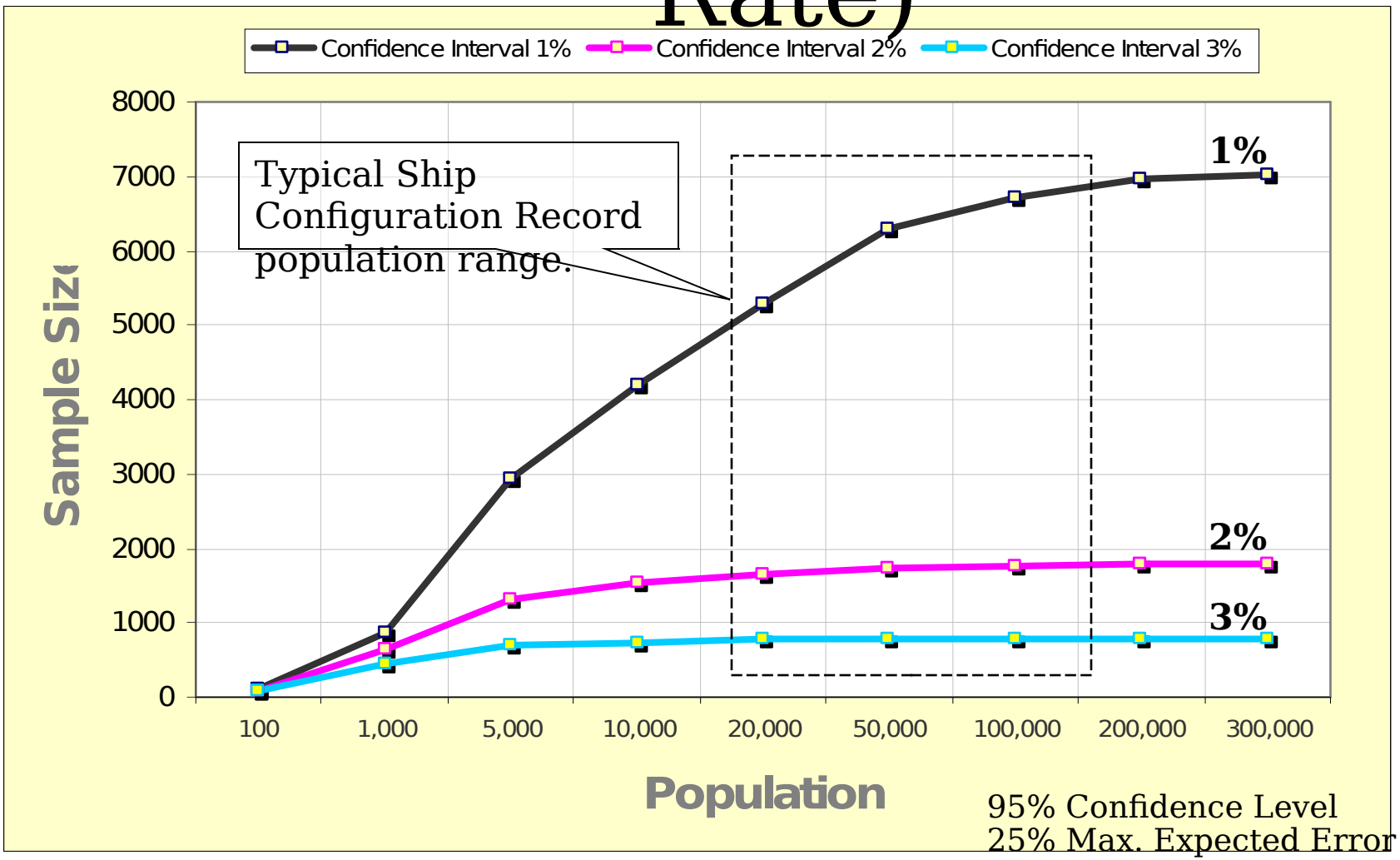
95% Confidence Level
3% Error Rate
25% Max. Expected Error Rate

Impact of Confidence Level



3% Error Rate
25% Max. Expected Error Ra

Impact of Confidence Interval (Error Rate)



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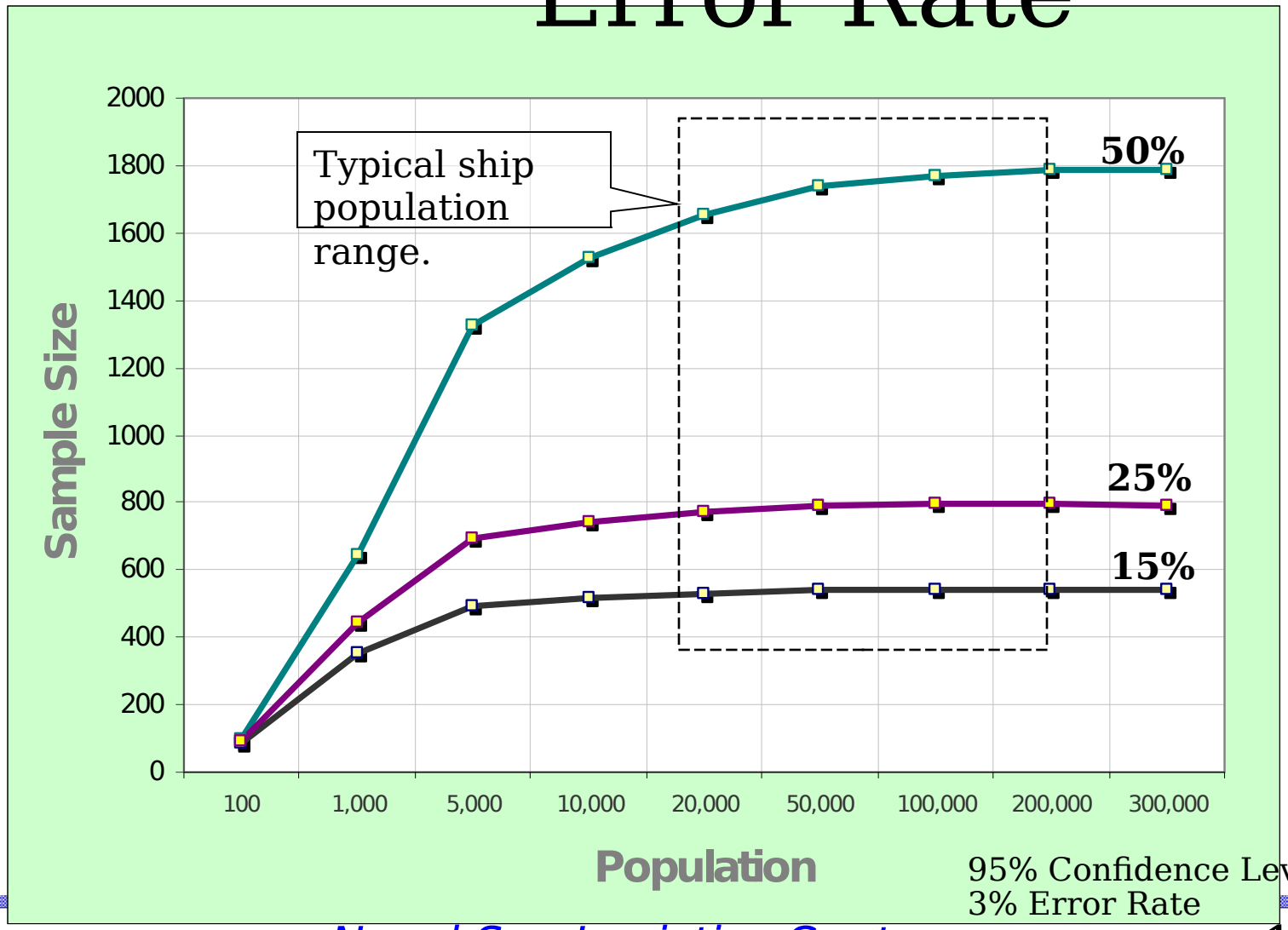
Impact of Maximum Expected Error Rate



Sample Summary

- Current revised sample criteria
  - Sound and objective sampling plan consistent with Navy guidance and Industry standards
  - Consistent methodology for measuring accuracy and comparing results
  - Appropriate for estimating shipwide configuration accuracy
  - Cost effective method

Validity rests on strict adherence to randomness of s

Recommendations

- Principle of Sampling: If sample is representative of accessible population, findings can be generalized to population
- Necessary to Refine Population (Universe)
  - *Before* the random sample is pulled
    - Minimize deferrals
- Refine Population w/ Filters
  - X-Compartment/ X-Service/ X-System
  - Valves